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Age and growth of the sharpsnout seabream *Diplodus puntazzo* (Cetti, 1777) inhabiting the Canarian archipelago, estimated by reading otoliths and by backcalculation

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Abstract

The yearly nature in growth increment formation in the otoliths of *Diplodus puntazzo* aged 1–10 years from the Canary Islands was validated. Each translucent zone in the otoliths represented an annulus with a year's growth represented by an opaque and its adjacent hyaline zone. Lengths at age were described by the specialised von Bertalanffy growth model ($L_\infty = 541$ mm, $k = 0.182$ year^{-1}, and $t_0 = -2.531$ years), the Schnute growth model ($y_1 = 171$ mm, $y_2 = 509$ mm, $a = 0.022$, $b = 2.59$) and the seasonalised von Bertalanffy growth model ($L_\infty = 546$ mm, $k = 0.176$ year^{-1}, $t_0 = -2.21$ years, $C = 0.712$, $t_s = 0.798$). Individuals grow fast during the first year of life, attaining approximately 45% of their maximum length. The body proportional hypothesis and the power length–radius relationship used to backcalculate the growth trajectories showed that the growth backcalculation model could be used to provide reasonable estimates of growth in this species. A power relationship ($a = 36.19$ and $v = 1.705$) was estimated between the total length and the otolith radius. Backcalculated lengths were similar to those predicted by the growth models. Growth parameters estimated from the backcalculated lengths at age were: $L_\infty = 508$ mm, $k = 0.197$ year^{-1}, $t_0 = -1.731$ years. Data on length and age used to estimate the parameters of the von Bertalanffy growth model showed that males and females have similar growth rates.

Keywords: Age; Growth; Reading otoliths; Backcalculation; *Diplodus puntazzo*; Canary Islands

1. Introduction

The sharpsnout seabream *Diplodus puntazzo* (Cetti, 1777) is a benthopelagic marine fish found in schools over rocky bottoms, down to depths of about 150 m. This species is distributed in the eastern Atlantic coasts, from the Bay of Biscay to Sierra Leone, and around the Canary Islands and Cape Verde. It is also found in the Mediterranean and Black seas (Bauchot and Hureau, 1990).

In the Canary Islands, *D. puntazzo* forms a considerable proportion of the catch associated with the *Diplodus sargus cadenati* demersal artisanal fishery. This species is captured by traps deployed on the bottom for 4–12 days at depths of 10–120 m. Currently, the catches of the juveniles of *D. sargus cadenati* and *D. puntazzo* are combined with six other shallow-water sparid species in a joint fisheries exploration scheme without managements regulations.

It is essential to understand the life history of *D. puntazzo* and manage it properly in order to maintain a sustainable fishery in the Canary Islands. There are not any studies on the biology of *D. puntazzo* in the Canaries and only data on its reproductive characteristics, based on specimens caught sporadically in the Mediterranean or specimens under controlled conditions, are known (D'Ancona, 1949; Lissia-Frau and Pala, 1968; Micale et al., 1996). The current study investigates the age and growth of *D. puntazzo* off the Canary Islands by reading otoliths and by backcalculation.

2. Materials and methods

A total of 698 sharpsnout seabreams was obtained monthly by a random method (≈25 individuals by month) from the commercial catches of the Gran Canaria island (Canary Islands, central-east Atlantic) between March 2001 and March 2003. Each fish was measured to the mm for total length (L_t) and weighed to the g for total body weight (W_t). The sex was assessed visu-

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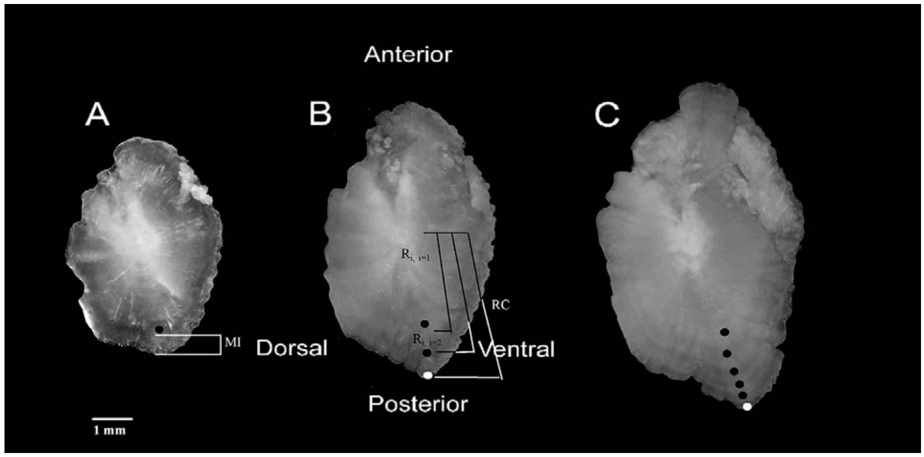

Fig. 1. Saggital otoliths of *D. puntazzo* from the Canary Islands. (A) A 1 year old (210 mm); (B) a 3 years old (350 mm); and (C) a 6 years old (429 mm). R_i is the radius of the *i*th band (distance from the centre of the otolith to the outer margin of the annulus), R_c is the radius of the otolith at capture, and MI is the marginal increment measured.

ally as males, females, immatures and intersexuals (individuals with ovarian and testicular tissues developed simultaneously) and each pair of *sagittal* otoliths were removed from the auditory bullae, rinsed in water to remove any tissue and stored dry for later age estimation.

The whole otoliths were fully immersed in ethanol and read under reflected light on a stereomicroscope at 10× magnification. The index of average percent error (IAPE) (Beamish and Fournier, 1981) as well as the mean coefficient of variation (CV) (Chang, 1982) were calculated to estimate the relative precision between readings. Low values of the indices indicated a good precision of age estimation.

To validate the seasonality in the deposition of opaque and translucent rings in the otoliths, the monthly mean marginal increment was analyzed. The method is based on estimates of the marginal increment of the otoliths of each fish for age class and estimates of the profile of the mean monthly marginal increment. The marginal increment (MI, 0.01 mm) was measured as the distance from the inner margin of the outermost translucent ring and the periphery of each otolith. Measurements were always made along the longest axis of the otolith. This study was carried out by age class. Owing to the wide range of ages encountered, however, there were insufficient samples to accomplish this standardization fully. It was necessary to combine the ages in two or more age groups representing fast, moderate, and slow growing individuals.

Once the periodicity and timing of ring formation were verified, the age of each fish was determined from the number of annuli, the assumed birth-date, and the sampling date. It was assumed that annulus formation began the 1st of November, corresponding to the peak of spawning in the species (unpublished data).

The difference between the date of capture and the birth-date helped the reader to estimate the annual fraction elapsed since the last birth-date, and the annual fraction was added to the number of complete hyaline rings read in the otoliths. The advantage of including the annual fraction elapsed since the last birth-date is that this avoids any potential bias in growth estimates due to the differences in sampling date.

Growth was described by the three parameters specialised von Bertalanffy growth model (Sparre and Venema, 1995), the four parameter Schnute growth model (Schnute, 1981), and the seasonalised von Bertalanffy growth model (Pitcher and Macdonald, 1973). The models were fitted to data by means of the Marquardt's algorithm for non-linear least squares parameter estimation.

Backcalculated size of each fish at the time of formation of each annulus was determined by substituting the measurement to each annulus into a body proportional equation (Francis, 1990). The radius of the *i*th band (R_i, 0.01 mm), distance from the centre of the otolith to the outer margin of the translucent ring, and the radius of the otolith at capture (R_c, 0.01 mm), distance from the centre of the otolith to the periphery, were measured (Fig. 1). Measurements were always made along the longest axis of the otolith. The relationship between the radius of the otolith at capture (R_c) and the total length was estimated as a linear function. It was estimated by regression of $\log(L_t)$ on $\log(R_c)$, consistent with the body proportional hypothesis. The length of an individual when the *i*th band was laid down (L_i) was calculated as: $L_i = (R_i/R_c)^v L_c$, where L_c is the length at capture and v is a constant derived from the power function that describes the relationship between the radius of the otolith and the total length of the fish (Francis, 1990). The von Bertalanffy growth curve was fitted to the backcalculated mean lengths at age by means of the Marquardt's algorithm for non-linear least squares parameter estimation.

3. Results

The number of individuals, and the mean, maximum, minimum and the standard deviation values of the total length and the total weight for immatures, males, females and intersexuals are presented in Table 1. Similar length and weight ranges, and similar lengths at age were observed for males and females.